Wisconsin Highway Research Program
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Research Implementation & Project Closure

Project Information	
(To be completed by WHRP staff when draft report is received) **Date completed:** March 31, 2006	
Project Title: Non-Nuclear Devices for Asphalt Pavement Density	**WHRP Project ID:** WHRP 06-12 **WisDOT Project ID:** 0092-05-10
Technical Oversight Committee: Flexible Pavement	**TOC Chair:** Len Makowski
Project Start Date: October 1, 2004	**WisDOT Project Manager:** Len Makowski
Project End Date: July 31, 2006	**Approved Contract Amount:** FY05 $99,977, 18 months
Final Report Dated: May 2006	**Actual Project Expenditures:** $99,977
Principal Investigator: Robert Schmitt **Organization:** UW-Platteville	**Co-investigators (including research assistants) and Organizations:** Chetena Rao and Harold Von Quintus Applied Research Associates

Implementation / Further Research Recommendations

(Information provided by TOC and WisDOT project manager when final report is approved) **Date completed:**

1. What WisDOT policy or practice does this research project pertain to? Please identify the specific section(s) of the Facilities Development Manual (FDM), Construction and Materials Manual (CMM), Standard Specifications, other manual, or accepted practice to which this research pertains.

2. Based on the results of this research, the following steps are recommended. (Please select either A, B or C, and provide detail in Items 3 to 7, below.)

☐ **A. No further activity is necessary. (Please skip to Item 7.)**

☒ **B. Revisions to WisDOT policy or practice are not appropriate at this time. However, to gain further value from this research, we recommend follow-up research and/or validation activities as detailed in 3 through 6, below.**

☐ **C. The Technical Oversight Committee recommends implementing changes to the following WisDOT policies or practices. (Please identify specific section(s) of specific manuals, where applicable):**

3. Describe the scope and objectives of follow-up research or implementation of specific changes to WisDOT procedures.
Pilot a non-nuclear density gauge test protocol where a project-specific calibration is conducted between the nuclear and non-nuclear gauges. Calibration to only the nuclear density gauge is recommended. Apply a 10-point calibration using the slope function, rather than the intercept and slope-intercept functions, since it has less error and a more simplistic approach for field purposes. A daily slope function more accurately adjusts non-nuclear readings than using a previous day's slope function. It is recommended that a daily slope function be computed until future data support a shift to using a previous day's slope function.

Specify a sample size for non-nuclear gauge testing of n=30 test sites per lot, based on a 95% confidence level, measured mat variability, slope-function error, and confidence intervals of +/- 1.0 pcf and +/- 0.6 % density.

Adopt a statistically-based tolerance value, or specified mean difference, that would determine if two non-nuclear devices are statistically different, in order to identify corrective action. Based on the data collected, it is recommended 30 test sites be used for independent sample comparisons, and 10 test sites for split-sample comparisons.

The following is a summary of possible issues that will delay the implementation process:
a. Operator Familiarity
Non-nuclear density gauges are a new technology to Wisconsin paving, however, they are not complicated to operate. Operators

should gain rapid familiarity with the gauges, similar to the first experience operating the nuclear density gauge.

b. Battery Life
A charged battery in the non-nuclear gauges lasts approximately 4 to 6 hours, much less than a nuclear gauge battery. The operator will want to recharge the battery after each day of paving, a practice that is not common with nuclear gauges. In addition, the battery compartment is not readily accessible in the non-nuclear gauges; manufacturers should be consulted to change batteries.

c. Manufacturer Recommendations
Non-nuclear readings are more sensitive to moisture than nuclear readings. The new test specification must enforce a maximum moisture index value of 10, otherwise erroneous readings will be measured. The PQI models have a moisture reading, however, the PaveTracker model lacks this feature.

d. Computing the Slope Function
Computation of the daily slope function in the new test procedure are straight forward, and should pose minimal challenges to the technicians operating the non-nuclear gauges. The operator simply divides the 10-point nuclear gauge readings by the 10-point non-nuclear gauge readings. Then, the factor is multiplied by all raw non-nuclear readings. The computations should reside with the field operators, and upper management involvement is not necessary. Slope adjustment computations can be an added component of the WisDOT Highway Technician Certification Program (HTCP) courses.

e. Test Site Layout
The implementation of a new specification will require a greater effort to layout n=30 test sites, as compared to the current n=7 test sites. Nuclear Density I technicians are familiar with random station and centerline offset computations, so it is a matter of performing more site layout, and not a new method of layout. Computations for the test sites can be updated using current HTCP manuals and practices.

f. Training
Education and training are key to piloting and implementing the new test specification. The published report offers detailed explanations of computations, and provided numerous tables with calculations. WisDOT may want to supplement the provided information with additional examples as necessary. Operator training is necessary and should be formalized within the HTCP, most likely in the Nuclear Density I course.

4. Details of Follow-up Research or Implementation Activities:

Task	Person responsible	Target completion date
1. Pilot Project Idea presented in this form will be presented as a potential agenda item for future Tech Team meetings.	Tom Brokaw	5/1/2008
2.		
3.		
4.		
5.		
6.		

5. Estimated cost, if any, for equipment, training, printing, etc.:
None

6. Expected benefits and how they will be measured (dollar savings, time savings, etc.):
Current QMP nuclear density specification:
Increased sample size will result in a reduction in acceptance risk levels for both WisDOT and contractors from current level of 20% to a proposed level of 5%. This will reduced risk exposure of WisDOT accepting deficient pavement density work, when in fact the work may be measured as satisfactory using current n=7 sample size. Likewise, the contractor payment risks will be minimized, since the current n=7 sample size may yield a deficient pavement density, when in fact the pavement density may be adequare. Benefits of the increased sample size are removal of 15% risk exposure during the acceptance decision. Actual cost savings will vary by pay factor assigned to contract bid price per ton of asphalt furnished and installed.

Proposed non-nuclear density specification:
No dollar or time savings at this time. Technology requires use of nuclear density gauge for calibration until non-nuclear density device technology improves. Immediate benefits of the non-nuclear gauge are lighter weight for the operator, shorter test time, and no nuclear licensing requirement.

7. Reasons for terminating activities related to this research project:

Project Closure

(Information provided by principal investigator and WisDOT project manager when final report is approved)
Date completed: July 31, 2006

Timeline and budget

1. Was the project completed on time (i.e., per the original contract between WisDOT and the performing organization)?
☐ Yes
☒ No

1a. If not, what additional time was needed to complete the project?
Review of final report by WHRP Flexible Pavements TOC
What were the reasons?
☐ Data access ☒ Reporting/revision delay
☐ Testing delay ☐ Research subcontractor delay
☐ Construction delay ☐ Work plan modification
☐ Administrative delay

2. Was additional funding sought for this project?
☐ Yes
☐ No

2a. If yes, how much?
Was the funding approved? ☐ Yes ☐ No
For what purpose?

Partnerships and facilities

3. Did this research effort include partnerships with other universities, agencies, or other stakeholders?
☒ Yes
☐ No

3a. If yes, please list. Include the locations of any out-of-state institutions.
Applied Research Associates, Inc. (formerly ERES) Champaign, Illinois

4. Indicate the location of facilities used:
☒ University
☐ Wisconsin DOT
☐ Other:

4a. Please describe the type of laboratory and testing facilities used.
Pavement core bulk density testing at UW-Platteville HTCP Lab

Student involvement

5. Were graduate students employed for this study?
☐ Yes
☒ No

5a. If yes, how many?
Number male
Number female

6. Did any of the graduate students use this research project in a published thesis or article?
☐ Yes ☐ Not sure
☐ No ☒ N/A

6a. Citations of published theses or articles:

7. Were undergraduate students employed for this study?
☒ Yes
☐ No

7a. If yes, how many? 3
Number male 3
Number female 0

8. If known, please list the graduate students' current occupations or affiliations (e.g., continuing graduate education, employed at a public agency or private firm, etc.) and completed degrees and awarding institutions.

9. If known, please list the undergraduate students' current occupations or affiliations (e.g., continuing graduate education, employed at a public agency or private firm, etc.) and, where applicable, completed graduate degrees and awarding institutions.
Employment with professional consultants and contractors in Wisconsin with work applications in pavement design and construction.